INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN
ICED 05 MELBOURNE, AUGUST 15–18, 2005

DEVELOPMENT OF A SIMPLE INFORMATION PUMP

P C Matthews, J D Keegan and J R Robson

Keywords: Information elicitation; focus groups; non-technical product evaluation; subjective evaluation; game theory.

1 Introduction

The need for high quality, non-technical, product evaluation has been acknowledged for a long time [1, 2]. These non-technical observations cover areas such as aesthetics, usability, desirability, fashion, etc., and are difficult to measure without recourse to the intended product market audience. A number of methods have been developed to facilitate this process, for example focus groups and survey questionnaires [3]. These methods tend to be costly and run the risk of boring the subject, resulting in poor quality information.

The aim of this work is to investigate the implementation of an alternative product evaluation methodology that is driven by the subjects. Central to this methodology is a competitive 'game' format that is designed to maintain the subjects' interest throughout the information gathering process.

2 Background

The Information Pump (IP) is a methodology that aims to counter the problems arising from traditional subjective product data collection [4]. The IP is a game theory based process that aims to maximise information extracted from a panel of subjects, while maintaining their interest in the process through a continuous panelist scoring method. The challenge with implementing this arises from the difficulty in executing the 'game'. In its original format, there is an assumption that the game is played with each player using their own PC to interact with the process. While this in theory allows information and scores to flow in a controlled manner between the players, it actually provides a major barrier to the wider adoption of the IP method. This barrier is two-fold: it is costly and complex, and it is not a natural manner for exchanging information.

The IP method has been described as a 'virtual focus group', but it includes significant differences to set it apart from more conventional methods. It was developed in response to the growing concerns amongst academics and product designers that existing evaluation techniques available were not conducive to extracting usable information from the customer. It was believed that the lack of incentive provision resulted in low motivation levels of the participants involved in the evaluation process. Resnick and Varian [5] stated that 'future systems will likely need to offer some incentive for the provision of recommendations' in order to encourage respondents to make evaluations and impart their information. The Information Pump is based upon a theoretical format for scoring two-person subjective reports, effectively in the form of

a two-person, non-zero sum game.

The initial applications of the IP method have focused on the visual aesthetics of concept cars. In particular, these initial tests concentrated on the function of the scoring system and incentive structure within the game. Two sets of participants evaluated products and other assorted visual stimuli using a web-based protocol. In order to monitor the effect of the scoring system and incentive structure, one group evaluated the products using the complete version of the IP whilst the second group used an interface that was identical in every respect apart from the exclusion of interactive scoring. The IP report [4] contains no detailed results to indicate the outcome or success of these preliminary investigations. However, according to Dahan and Hauser [6] there were significant indications that the respondents using the absolute version of the IP provided statements and commends that were deemed by independent judges to be considerably more creative than those of their counterparts in the second group.

The core objective is to develop a low cost version of the IP method. This will use the game theory approach to maintain interest among participants and maximise information extraction, but remove the need for each participant to have their own PC interface to the game. This will require replacing both the inter-player communication method and the score keeping/reporting.

3 The Information Pump

The Information Pump is a method to extract subjective information in the form of a discussion group with incentives for high quality statements. A group of participants will view a product, and instead of simply voicing their own opinions, they will take turns to pose ('encode') statements that are relevant to the product. Each participant then responds with their own view (agree or disagree) and also an an attempt to guess the opinions of the other participants, using a payoff scale of 1 to 10. The scoring system introduces an element of competition into the game, with each participant receiving a personal score.

A 'dummy' participant, who cannot see the product visible to the other encoding participants, is also present in the game. The dummy is not required to make any statements, but must make a conscious effort to guess the responses of the other participantss. The more information the dummy learns through the game, the fewer points the encoders can score. This provides incentive to the encoders to vary their statements, which results in a richer information source in terms of product evaluation.

At the end of the game, all score are accumulated, and the winner is the participant who has provided the most qualitative and quantitative information during the game. This participant can be noted as a 'good player' and can be encouraged to return for future product research. The designer can now use the information generated during the process as product evaluation data.

4 Objectives

The aim of this research was to develop a simplified version of the Information Pump. In its original implementation, the IP requires a costly and complex networked computer system that is not accessible to small enterprises. A simplified approach has been developed and was tested for effectiveness. Effectively, the following hypotheses are being tested:

1. The Information Pump will provide a richer source of information than the conventional questionnaire methods;
2. Feedback through the IP method will be most effective in highlighting aesthetic features and aspects of product design; and
3. The 'competition' format will promote innovative and creative lines of thought as encoders aim to limit the success of the dummy and maximise their score.

By running a series of experiments on different products, it was possible to also identify criteria for products that are suitable for analysis using the IP. Further, guidelines for how to present the product to an analysis panel are also identified from the empirical work.

Finally, as part of the development of a simplified IP implementation, a key objective is the development of an efficient method for extracting the salient product evaluation information from the process.

5 Empirical Methodology

The core empirical method used closely mirrored the original suggested panel setup [4]. The principal difference was that in this simplified implementation, all participants were located in the same room. This meant that the participants could communicate with each other verbally, rather than textually via a computer terminal. While this simplified the communication channel between the panelists, it did make the capturing of this communication more difficult.

The empirical work was undertaken as part of the engineering masters' dissertation project of two of the authors. As such, the experiments used other students as panelists. While this will have affected the nature of the panel composition and the information extracted from these panels, it did not hamper the analysis of the implementation.

The experiment series initially repeated a previously reported experiment, with the aim of replicating the results. On successful replication, the initial experiment was analysed for weaknesses and other 'local' issues that would need to be addressed in subsequent experiment runs.

Each experiment was performed in a small seminar room. The layout of the room was structured so that the encoders were seated around a table in view of each other and the product under discussion. A partition panel was placed at one end of the table so that the dummy could be seated in the same room but without visual access to the product. The games were observed by the researcher, who could move around the room if necessary. 'Official' statements were recorded by hand on paper forms by each participant, and these forms were also used to record the agreement and confidence levels of the statements being issued. These forms were analysed after the game process to extract product information.

The following sections present the results from three experiments from the experiment series, illustrating the benefits and weaknesses of the initial development of a simplified Information Pump.

5.1 Experiment 1: Datum

The first experiment served two purposes: to replicate as near as possible the original IP experiment and to compare the IP with alternative product evaluation methods. Two games were

played in this experiment. The first evaluated a gentleman's diving watch and the second evaluated a high end sports car. Both products were prohibitively expensive to acquire for the purposes of this experiment, and hence images of the product were provided as cues to the encoders. This is not an unreasonable restriction, as the IP is likely to be used to evaluate concepts that have not progressed to the detailed prototype stage.

The panel for these games consisted of four participants, three of which were encoders and one assumed the role of the dummy. Prior to the start of the first game, all the participants were fully briefed on the functions they were to perform in the game. A paper copy of the game process format was made available to them and they were able to refer to this during the process. Each participant was also given a number of identical printed forms on which they were to record their answers to the statements and note their confidence levels of the statements. These forms were collected at the end of the process for analysis. In this game the participants were discouraged from interacting with each other beyond verbal communication. This was to maintain the competitive nature of the game and avoid direct co-operation between participants. Questions and statements were posed by writing them on a large flip chart which was visible to all participants. The contents of the flip chart were on display throughout the whole game process to allow the participants to review the game history.

In addition to extracting product information through the IP, a traditional questionnaire provided. This questionnaire was specifically designed to extract information in the aesthetics and image perception of the products. These are similar characteristics that the IP aims to extract from the participants. The questionnaire used 'Product Personality Profiling' methods to encourage the participants to impart information they might have been unaware that they possessed or found difficult to express. This method also helps identify the typical customer base of the product.

Diver's watch The dummy was selected at random and all participants were briefed on their respective roles. Any queries about the game process were answered at this point to avoid interruptions during the game. The starting encoder was then selected at random, and the order of play proceeded in a clockwise direction around the table. Each encoder wrote their statements on the flip chart and returned to their seat while the remaining participants recorded their responses on the prepared forms. Once all participants indicated their readiness, the game passed onto the next encoder who posed the next statement in the same way. This continued until all participants had submitted five statements each. At this point, the completed forms were taken from the participants and they were presented with a 'standard' product evaluation questionnaire.

Sports car During the course of the diver's watch game, it was observed that some of the participants were struggling to focus upon the key design features of the product and instead were making general observations on the appearance of the product. In order to focus the encoders on the aesthetics of the product, they were presented with a list of 'aesthetic elements' from which to aid constructing their statements or questions. The game process continued in the same manner as the diver's watch game, but swapping the dummy for another encoder. The three encoders asked a total of fifteen questions and once again were given a traditional product evaluate questionnaire at the end of the process.

After the two games were played, the scores were computed and reported back to the participants. It was not possible to provide 'live' scores during the game, as this required the forms

back from the participants.

5.2 Experiment 2: Bottle aesthetics

The second experiment largely repeated the methodology for the first experiment, but a 'traditional' product survey was no longer provided at the end of the game process. The key difference to the running of the game was that participants (both encoders and dummy) could now ask follow-up questions on the statements for further clarification. However, the encoder posing the statement had the discretion of not answering the question. Once all clarifications had been cleared, the participants filled in the forms as in Experiment 1. An audio recording of the session was made for further reference.

This experiment focused on the aesthetics of the bottles used for packaging mineral water. Two games were executed, one for a 'branded' mineral water and the other for a 'white product' brand of mineral water. Each game was played with three encoders and one dummy. The game process lasted for about 20 minutes each.

At the end of the experiment, the players were asked to reflect on the game process. The information gathered from this focus group type discussion was used to modify the next and final experiment.

5.3 Experiment 3: Radical car styling

The final experiment consisted of a single game executed with four encoders and one dummy. The product was the Renault Mégane, a car with a radical rear styling. Each encoder was issued with a different photograph of the car. The dummy was informed that the product under review was a car, as this allowed the encoders to use language that would reveal this fact but nothing more. Each encoder made a total of four statements during the game process, providing a total of 16 statements. The participants were informed that the game was being scored competitively, and there would be a prize for the highest scoring encoder. The scoring method was explained to the participants before the game started.

6 Results

The purpose of the Information Pump is to extract high quality and usable information from the participants about a given product. This information can then be used by designers, manufacturers or marketers to refine the product to the preferences of the customer base or to improve certain features. The experiments in this research programme were focused on extracting the information from a sample of subjects. It was never intended to use this information as part of a design process, and hence the products used were not prototypes but the final product. As final products were used, these had published marketing material from which the 'design intentions' could be extracted and compared to the participants' comments. In effect, the laboratory conditions reversed the normal flow of information: participants' responses were measured against marketing material whereas normally the participants would be affecting the marketing material.

For the purposes of post-game analysis, the responses were grouped thematically. The encoder forecasts for each statement were used to measure the confidence the players had in the validity

of each statement by assigning a score for the statement. Thus, the statements could be ranked from high to low confidence. The high ranking statements were those with great consensus between the participants while the low scoring ones were statements where the participants disagreed with each other. This information can be used by designers and marketers to identify the issues that are of primary concern to the customer base.

6.1 Experiment 1: Datum

Diver's watch The manufacturer's description of the watch highlights its functionality in the marine environment, specifically targeted at those interested in diving or sailing. In addition to this, they stress the importance of using quality materials and precious metals to provide the product with a classic design. The results of the Information Pump analysis are consistent with the manufacturer's description and focus upon the materials used to make the product and its expense (IP statement: 'looks expensive'). The evaluation also highlighted elements of the product's intended use as diving equipment. However, it was the market and customer base that the participants were most able to identify, uniformly agreeing that the product was designed and targeted towards men. The style of the watch itself caused some disagreement between the participants who were unable to decide whether its design was traditional or modern. This was indicated by a zero score.

It was apparent during the investigation that the participants struggled to develop the creative and inventive lines of thought as hypothesised. There appeared to be an absence of competition, which was borne out by the lack of focus and interest exhibited. As a result, the questionnaire proved to be more effective in identifying aspects of the product's design that required improvement.

Although the results of the IP evaluation had obvious benefits for the end user, the experiment was inconclusive in determining whether or not the method is more effective than the conventional techniques with which is was compared. The theoretical hypotheses that incentives and competition promote more effective extraction of information were also unfounded. However, it must be stressed that the participants could not compare their relative scores during the game process, the scores only being calculated after the game had been completed.

Sports car The data obtained from the manufacturer's website describes the vehicle as being the 'best ever produced in terms of looks and performance'. Its styling is based upon that of a classic sports car built around the most advanced technology available. The aim of the designer was to create an aggressive, powerful and fast sports car that was also safe, as indicated by the inclusion of twin roll bars. The design description also remarks on the incredibly compact nature of the vehicle. The encoders were very confident and accurate in their assessment of the styling and design intentions as indicated by the ranked statements (IP statements: 'Product looks sleek', 'Uses aggressive styling', 'Looks very sensuous', 'Well balanced', 'Compact in design and appearance'). The encoders also conveyed their perception of the vehicle's performance, describing it as 'fast' and capable of 'providing the driver with an adrenaline rush'.

Each of these statements correspond to the exact intentions of the designer. The evaluation also extended beyond the aesthetic analysis of the product, highlighting the quality and identifying potential markets. For example, the vehicle was described by IP statements as masculine with the owner being 'young with no children'. This clearly identifies the market as men with significant disposable incomes who are looking at alternatives to larger, more family oriented

vehicles.

In contrast with the first game process, the information gathered with the IP proved to be more effective when compared to the results obtained using the questionnaire. Although some of the information obtained continued to be observational, the majority of it focused upon specific aspects of the product's design. The results of the questionnaire study highlighted some of the drawbacks of questionnaire methods as have been previously highlighted [7]. It was found that if respondents did not understand a question they often failed to complete it or spoil it. In addition, questionnaires were incapable of eliciting such precise information on the styling of the vehicle due to their restrictive design.

6.2 Experiment 2: Bottle aesthetics

This experiment ran two IP games on similar products (bottled mineral water) with significantly different styling and branding. The participants were provided with a reference sheet for during the game that included a 'payoff' matrix. The payoff matrix specified the points a participant would score on evaluating a given statement which is voted by the participants as being either 'true' or 'false'.

The branded mineral water bottle resulted in a varying set of statements made by the encoders. Statements that were agreed upon by the panel included: 'This product appeals to someone who values aesthetics' (unanimous *disagreement*) and 'This product would withstand rough handling in the back of a car after purchase' (unanimous agreement: all players thought the glass packaging was sufficiently strong). A statement that scored poorly, i.e. there was a mixture of agreement and disagreement between players, was 'People buying this product would not want something this size'. The mixed reaction to this statement suggests that the manufacturer might wish to consider alternative packaging size to appeal to a new market segment or to clarify the product image.

The dummy had to make three statements during the course of the game process. The strategy the dummy adopted was to listen to the reaction of the other participants after each statement had been made. The first statement the dummy made was 'This product is aimed at the elderly' which caused confusion amongst the encoders resulting in mixed answers. The dummy noted the confusion and on the second attempt tried a different line of questioning posing 'This product would market better if it was made of an alternate material'. All participants responded positively to this, agreeing that an alternative material would be an improvement. At the end of the game process, the dummy was still unaware what the product was, and although the dummy had been able to establish a more appropriate line of questioning, no knowledge of the product was gained. This suggests that the encoders were successful at varying the statements sufficiently that the dummy was not able to learn anything significant about the product through redundancy in the encoder statements.

The 'white product' mineral water extracted a number of similar styled statements and had a similar end result as the 'branded' game. This included statements such as 'This product is quite sturdy', which elicited a request for the posing encoded to define 'sturdy' and resulted in panel agreement. A statement resulting in mixed reaction was 'This is an attractive product', suggesting that the participants disagreed on whether they had strong feelings on the attractiveness of this product. Similar to the previous game process, the dummy once again had no idea about the nature of the product.

After the two game runs, the participants discussed the experiment from a their perspective.

The first point of discussion was the dummy's role and the line of questioning being difficult to answer when not particularly relevant to the product. The presence of the dummy was seen as positive as it introduced some amusement to the process and provided a challenge to keep the dummy from learning the product. However, it was also pointed out that this could be seen as a distraction when the dummy issued statements which required considerable clarification. As the IP is a new type of 'game', the participants felt that the unfamiliarity with the process provoked some confusion which lead to forgetting about the competitive nature of the process. Finally, the participants expressed that it took too long for encoders to create their statements. It was felt that a list of aesthetic or other relevant key words would speed the creation of relevant statements for the game without overly restricting it.

6.3 Experiment 3: Radical car styling

The final experiment was a single game played with four encoders and one dummy. Each encoder was issued with a different photo of a Renault Mégane and the dummy was informed that the product under discussion was a car. The encoders took turns at writing down statements regarding the vehicle on a flip chart that was visible to all participants. The dummy was positioned so that he could see the flip chart, but not the other participants. This prevented the gathering of any information about the product as a result of the encoders expressions or other body-language. In this experiment, the dummy did not pose any statements. Similar to the other games, once the statement was written down, the other participants had to decide whether they personally agreed or disagreed with the statement and how they felt the the remaining encoders felt about the statement. The scoring system had been clarified, and a prize was offered to the highest scoring encoder to encourage the competitive aspect of the game.

The Renault Mégane was selected due to the controversial response it received when released into the public market. Renault designed the vehicle for the 'individual driver' who expects a car that will not only provide safety, performance and respect for the environment, but also intelligence. Renault made the following statement about the Mégane:

> "The daring and unmistakenly modern design of the Mégane underlines Renault's international reputation as one of the most innovative of today's car makers. But it is not only advanced stylistically. It is also on the leading edge from a technical standpoint; and the technology is employed, not for its own sake, but to provide a safer, easier and more stimulating driving experience."

In today's market, many cars are starting to look increasingly similar. Renault has incorporated many styling aspects to make the new Mégane stand out. The marked produced a mixed response to such an unusual design, with most opinions on one extreme or the other. Viewed from the rear, the Mégane looks like any other family hatchback with a somewhat smaller rear window. From the side, however, it is hard to miss the protrusion of the 'bustle' which is the main cause of difference in public opinion.

A high scoring statements included 'This car looks old fashioned and boring'. This received a high *negative* score, indicating a strong disagreement by the panel on this statements. Further, the high score for this statement indicates that the participants were also confident of the other participants' response to this statement as well. This suggests that the Renault Mégane is indeed perceived as a lively and modern car. In contrast to this statement was 'I would love to own this car'. This received a low score, indicating a split in the panel's view of the vehicle.

7 Discussion

This investigation of the Information Pump has generated a relatively large number of individual pieces of product information, each rated with a point score. To extract a similar level of information using a questionnaire based method would have required a complex and precise form which would be time consuming to complete. By prompting ('pump-priming') the game process with relevant keywords, it was possible to exert a degree of control and provide some direction to the IP such that the information extracted is more relevant to the conceptual design stages. In this sense the IP has a practical relevance to previously reported work in developing 'a general vocabulary for discussing aesthetics and perceptions in industrial design' [8]. In this situation, it is vital to know what the customer thinks about the product. Designing a questionnaire to do this would result in information being lost (or not gathered) due to the inflexibility of the questionnaire method. There is also considerable evidence from the results of the experiments to suggest that the IP is equally effective as a marketing tool to identify potential target markets for the product. Participants were much more confident in evaluating statements based upon market and customer base than any other group. In addition, the method appeared to work best when applied to tangible products that the participant can interact with. The experimental results indicate that the volume and quality of the information increased considerably in this situation. This finding is in agreement with results from other work reporting that 'direct experience with a product leads to enhanced opportunity and ability to process product related information' [9].

As a result of this investigation, the following guidelines are proposed for future implementations of a simple Information Pump:

1. No communication should take place between participants other than through approved appropriate media. This ensures any information received reflects the true opinions of the participants.

2. Multiple dummies should be used to reduce the effect of guessing on the encoders' scores. This will provide a more accurate representation of the knowledge level of the dummy panel and allow the dummies to compete with each other.

3. The provision of information should be strictly controlled. Participants should be provided with feedback on their performance and prompt sheets to encourage creative and insightful statements. There is no requirement to provide the dummy with any information.

4. Games should be split into distinct sections. This allows the participants to focus upon specific features of a product in turn, ensuring they have less to assimilate and provide more relevant information. For example, analysis of a car could concentrate on the exterior, interior, and power-train as separate sections.

5. Statements should be ranked in order of encoder confidence levels. This will indicate how valid each participant perceives the information to be and reduces noise introduced by dummy guesses.

6. If possible, participants should be presented with tangible products to allow interaction. It has been shown that this increases the ability of the participant to impart relevant information.

In concurrence with these guidelines, a structured method has been developed and evaluated. This method enables a range of products to be evaluated. It has been shown that the competitive game format of the IP encourages the respondents to provide accurate and relevant information.

8 Conclusions

This research has shown that the Information Pump can be reconfigured into an accessible low technology implementation. The competitive game nature of this method maintains the interest of the panel subjects. However, the immediate results of the game process require further analysis to extract the product evaluation information. The advantage is that the subjects can provide a wider range of feedback than they would do using the traditional questionnaire or other guided feedback methods.

References

[1] A Griffin and J R Hauser. The voice of the customer. *Marketing Science*, 12(1):1–27, 1993.

[2] R Yalch and F Brunel. Need hierarchies in consumer judgments of product designs: Is it time to reconsider Maslow's theory? *Advances in Consumer Research*, 23:405–410, 1996.

[3] S Spiggle. Analysis and interpretation of qualitative data in consumer research. *Journal of Consumer Research*, 21(3):491–503, 1994.

[4] D Prelec. A two-person scoring rule for subjective reports. Technical report, MIT Sloan School of Management, 2001.

[5] P Resnick and H Varian. Recommender systems. *Communications of the ACM*, 39:87–93, 1996.

[6] E Dahan and J R Hauser. The virtual customer. *The Journal of Product Innovation Management*, 19:332–353, 2002.

[7] N E Synodinos. The "art" of questionnaire construction: some important considerations for manufacturing studies. *Integrated Manufacturing Systems*, 14(3):221–237, 2003.

[8] K W Johnson, T Lenau, and M F Ashby. The aesthetic and perceived attributes of materials and products. In A Folkeson, K Gralén, M Norell, and U Sellgren, editors, *Proceedings of the 14th International Conference on Engineering Design*, Stockholm, 2003. Design Society.

[9] S C Mooy and H S J Robben. Managing consumers' product evaluations through direct product experience. *Journal of Product and Brand Management*, 11(7):432–446, 2002.

Dr Peter C Matthews, MIEE
School of Engineering, Durham University
Science Laboratories, South Road,
Durham DH1 3LE, England
Phone: +44 (0191) 334 2538,
Fax: +44 (0870) 133 6961
http://www.durham.ac.uk/Engineering/
E-mail: p.c.matthews@durham.ac.uk